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Executive Summary

RESOURCE & POTENTIAL RECLAMATION EVALUATION

McCALLUM STUDY AREA

Report No. 26

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This report was proposed through the efforts of the Bureau of Land Management, Bureau of Reclamation, and Geologic Survey as part of the Federal Coal Management Program.

16. ABSTRACT
The purpose of this investigation was to collect baseline data for establishing reclamation objectives and lease stipulations. The report includes data on climate, biological and cultural resources, physiography, geology, coal resources, soil overburden, vegetation, and hydrology. The study area is within Moffat County in Colorado. The site climate is highland continental. Average annual precipitation is less than 16 inches. The area is composed of seven ecological subdivisions or range sites as follows: mountain loam, dry mountain loam, drainage bottom, clay pan, valley bench, dry exposure, and salt flat. The Coalmont Formation which occurs within the Study Area is a maximum of 12,000 feet thick and consists of micaceous and arkosic sandstone, minor conglomerate, mudstone, claystone, carbonaceous shale, and coal. The Sudduth coalbed, occurring 50 to 250 feet above the base of the Coalmont Formation, contains significantly thick coal deposits. Results of the land suitability survey show that approximately 87 percent of the Study Area has adequate material for postmining reclamation purpose. Approximately 67 percent of the Study Area is class 1. Class 2 and 3 land comprise about 10 percent each. The remaining 13 percent of the Study Area was Class 6. The overall effect of mining on hydrology of the area should be minimal, primarily because only small areas of the basins will be mined.

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EXECUTIVE SUMMARY
on
Resource and Potential Reclamation Evaluation
of
McCallum Study Area,
Jackson County, Colorado

INTRODUCTION

Recent energy demands focused attention on coal sources existing primarily in the Rocky Mountain and the Northern Great Plains Provinces of the Western States. The BLM (Bureau of Land Management) has responsibility for encouraging and assisting in meeting these energy demands for ensuring sound reclamation on surface-mined public lands to return them to a productive and useful state. Reclamation (Bureau of Reclamation) and USGS (United States Geologic Service) have cooperated with BLM in the preparation of this report.

Purpose

The purpose of this study is to determine the reclamation potential of the McCallum area near Walden, Colorado, problems involved in reclaiming the area, and measures required to return the area to the land form and vegetative cover existing prior to mining.

Authority

This study was authorized by the Public Land Administration Act of July 14, 1969 (74 Stat. 506), the Federal Land Policy and Management Act of 1976 (Public Law 94-579), and the Surface Mining Control and Reclamation Act of 1977 (Public Law 95-87).

GENERAL DESCRIPTION

Location and Setting

The McCallum Study Area, as shown on figure 1, is located approximately 8 miles east of Walden, Colorado. The lands studied lie within Jackson County and include T. 9 N., R. 78 W., sec. 22 - all; sec. 23 - all except W1/2 of the NE1/4 of the NW1/4; sec. 26 - all except E1/2 of the SE1/4 and the SW1/4 of the SE1/4; sec. 27 - all, and sec. 28 - all.

The surface ownership in the Study Area is public lands administered by BLM. These lands occur at an elevation between 8,550 and 8,100 feet. The coal minerals are owned by the Federal Government.

Present Land Use

The present resource in the Study Area is used for cattle grazing, wildlife, and as a watershed that provides forage for cattle. Livestock utilize the allotments in the spring and early summer.

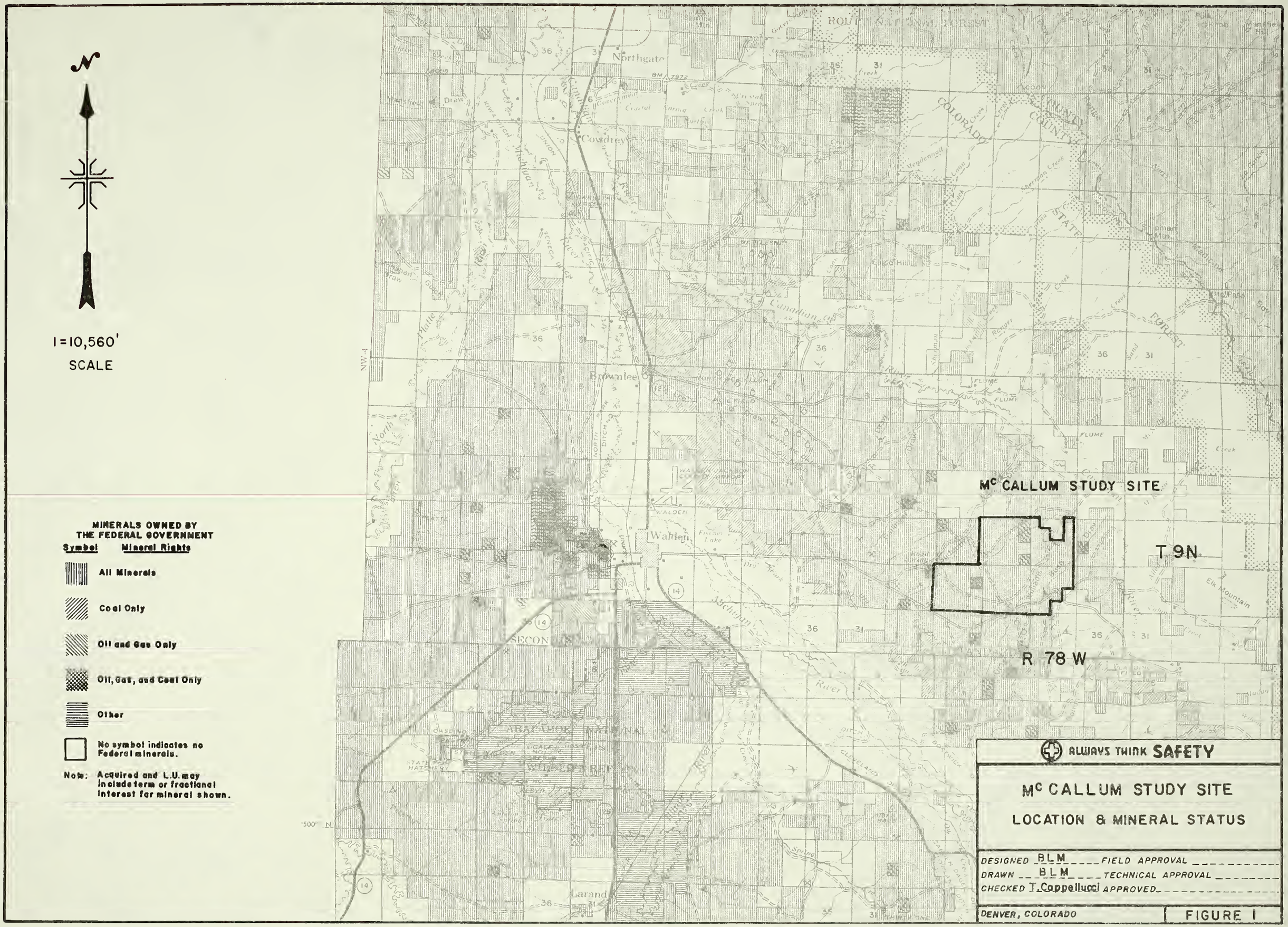


Figure 1. - McCallum Study Area location and mineral status.

Watershed management, an existing land use, includes soil and water objectives for maintenance or improvement of water quantity, quality, and timing, and soil productivity and stability.

The area presently provides important habitat for sage grouse, antelope, mule deer, various raptors, rodents, and songbirds.

Reclamation Objectives for the Study Area

The reclamation objectives for the McCallum Study Area in North Park are to return it, as nearly as possible, to the landform and vegetative cover that existed prior to mining. The area is native rangeland with livestock grazing, wildlife use, and watershed management as the major land uses. Postmining reclamation should ensure the continuance of these uses at their present capabilities, or improve upon them.

Postmined Land Use

The postmined land use for the McCallum Study Area should be the same as present land use. Multiple use management will be applied to all federally owned surface land.

Reclamation Alternatives

There were no alternatives planned for postmine use because there is no current land use plan for the area. Additional alternatives may be identified later in a Resource Management Plan which is being prepared.

CLIMATE

Temperature

Large-scale geographical features have a pronounced effect on the climate of North Park and the McCallum area. Walden experiences a large seasonal range in temperature ranging from a mean January temperature of 15 °F to a monthly mean temperature of 59 °F in July. Day to night (diurnal) temperature variations are also large because of the high elevation of the area and the interior mountain-valley location. During the winter months the diurnal temperature range averages 25 °F, increasing to nearly 40° in midsummer to early fall.

The coldest temperatures usually occur in January and February. The average freeze-free period for Walden, is 33 days with July and early August being the least likely period for experiencing subfreezing temperatures. However, daytime temperatures stay well above freezing throughout the summer season, and daily maximum temperatures of 32 °F and below occur on an average of 75 days per year.

Precipitation

North Park is a semiarid area. The entire interior of North Park averages less than 16 inches of precipitation annually. Measurements at Walden indicate that the annual average precipitation (1938-1979), including the water equivalent of winter snowfall, is only 9.67 inches. Since 1937, annual precipitation totals at Walden ranged from a low of 5.92 inches in 1964 to a high of 13.56 inches in 1951.

Winter (usually defined as October through April) is the driest time of the year in the center of North Park, even though the same period is the wettest season in many of the surrounding mountains. Practically all winter precipitation in the North Park region falls as snow.

The five summer months, May through September, account for about 60 percent of the annual precipitation in the Walden area (about 6 inches).

The greatest 1-day precipitation total recorded at Walden was 2.19 inches: however, daily amounts in excess of 1 inch are extremely rare. Daily rainfall amounts of 0.50 inch or greater occur an average of two times each summer. Rainfall amounts of 0.10 inch or greater on the average occur 18 days each summer.

Other Elements

North Park and the immediate McCallum area experience frequent and strong winds during winter and spring. The prevailing wind direction is from the southwest, and wind gusts in excess of 40 mi/h are not uncommon during the winter months. The result is considerable blowing snow which frequently causes very low visibilities and ground blizzard conditions. The blowing snow tends to pile up in huge drifts in protected areas while exposed areas are sometimes blown completely clear. Winds are more gentle and wind directions are dominated by local topography during the summer and early fall.

Only plants which can tolerate short growing seasons have a chance for survival and establishment in the McCallum Study Area.

ENVIRONMENTAL PROFILE

Biological Resources

The McCallum Study Area provides habitat for a variety of wildlife species associated with the sagebrush-grassland ecosystem. The more common species expected to inhabit the area are:

Possible mammals

White-tailed jackrabbit
Cottontail rabbit
Richardson's ground squirrel
Sagebrush vole
Coyote
Red fox
Badger
Striped skunk
Mule deer
Pronghorn

Possible/probable birds

Marsh hawk
Red-tailed hawk
Swainson's hawk
Golden eagle
Prairie falcon
Sage grouse
Mourning dove
Horned lark
Sage thrasher
Sage sparrow
Brewer's sparrow

Cultural Resources

Presently, about 72 percent of the Study Area is inventoried for cultural resources. Nine cultural sites are identified. Seven prehistoric sites are identified as open lithic scatters or areas exhibiting the by-products and waste products of stone tool manufacture. One prehistoric site has a subsurface deposition of cultural remains. The single historic site is the relatively recent Conrad Coal Mine.

Visual Resources

The visual resources of the McCallum Study Area are similar to those of the surrounding North Park Area. The VRM (Visual Resource Management) Class for the area is designated as Class III and Class IV.

PHYSICAL PROFILE

Geology

The McCallum Study Area lies in the northeastern portion of an intermontane basin known as North Park which is located at the north end of the Southern Rocky Mountains physiographic province. North Park is bounded on the northeast by mountains of the Medicine Bow Range; on the southeast by mountains of the Front Range; on the south by mountains by the Rabbit Bars Range; and on the west by mountains of the Park Range. These mountains rise to altitudes of 11,000 to 13,000 feet, while the floor of the park is characterized by a rolling topography averaging 8,100 to 8,300 feet above sea level.

North Park is a large structural topographic basin formed by the uplift of the Park Range and Medicine Bow Range, and possible depression of the park floor. The surrounding mountain ranges are composed of Pre-Cambrian granites, gneisses, and schists, while the park floor is made up of sedimentary rocks ranging in age from Permian to Recent.

The sedimentary beds are tilted upwards around the basin boundary on the east, south, and west with dips toward the center of the basin. The north end of the basin is bounded by the Independence Mountain fault where the crystalline rocks of Independence and Watson Mountains were thrust over the sedimentary sequence at right angles to the strike of the beds.

Another major structure is the North Park Syncline that trends northwest from the southeastern portion of the park to Delaney Butte. The smaller Johnny Moore Syncline and McCallum Anticline are found in the northeastern portion of the park east of Walden. This anticlinal-synclinal sequence also trends north-northwest. McCallum Anticline is important locally because of the exposed coal beds along the eroded limbs of the anticline.

Coal

USGS in cooperation with BLM and Reclamation, collected and analyzed representative coal samples from the McCallum Study Area. Twenty-eight samples (24 coal and 4 coal-associated rock) were analyzed for the area. At about the same time, 16 samples (12 coal and 4 coal-associated rock) were collected and analyzed from the nearby Coalmont area.

The Coalmont Formation is the most widespread unit in the two coal areas and is the only formation containing significantly thick coal deposits. The formation is a maximum of 12,000 feet thick and consists of micaceous and arkosic sandstone, minor conglomerate, mudstone, claystone, carbonaceous shale, and coal.

The two major coal beds in the Coalmont Formation are the Sudduth, occurring 50 to 250 feet above the base of the Coalmont Formation; and the Riach, occurring approximately 3,000 feet above the base. The two coal beds never have been found together in one section. The Sudduth bed occurs only in the McCallum Study Area in northeastern North Park, and the Riach coal bed occurs only in the Coalmont area in southwestern North Park.

INTERPRETATIONS FOR SOIL AND BEDROCK MATERIAL

Major Soil Bodies

The major physiographic units of the McCallum Study Area are: (1) gently sloping outwash fans and terraces; (2) hills, ridges, and valley side slopes, and (3) narrow smoothly incised ephemeral stream valleys. Following are general descriptions of the soils and topography associated with these physiographic units.

The physiographic unit of gently sloping outwash fans and terraces comprises 50 percent of the Study Area. This unit is the most important from the standpoint of quality and quantity of material suitable for use as a revegetation media. The west one-half of sections 22 and 23 is almost exclusively comprised of outwash fans.

The soils of this physiographic unit are formed in outwash and alluvium on fans and terraces. They support a relatively productive plant cover of mixed short grasses and forbs. The land is used for grazing. The soil depth usually is greater than 60 inches to bedrock. Medium and moderately fine textures are dominant and include sandy loams, fine sandy loams, sandy clay loams, and clay loams. Slopes generally range from 3 to 6 percent.

Water readily infiltrates these soils and percolates freely through the soil profile. Penetration of roots usually is more than 20 inches, but if the soil mantle is thin, root penetration is more restricted.

The physiographic unit of hills, ridges, and valley side slopes comprises about 47 percent of the Study Area. The soils were developed from weathered sandstone, siltstone, and shale. Slopes are variable within these landforms, ranging from 6 to 35 percent. Generally, the soils display weakly developed solum or no development. The major factor which impeded solum development was steep slopes. Thickness of soil material ranges from very thin to deep. The shallow soils (less than 20 inches to geologic material) are located on ridge tops, steeply sloping hillsides, and on upper stems of drainageways. The deeper soils generally are confined to colluvial slopes and alluvial deposits along drainageways.

The surface layer of these soils is commonly hard and noncalcareous. Textures range from loam to silty clay. Water infiltration rates are moderate to moderately slow. Downward movement is generally restricted throughout the profile.

Range is the primary use of tracts in the physiographic unit. The steeper hillsides and angular ridges support only a sparse cover of short grasses and forbs.

The physiographic unit of smoothly incised ephemeral stream valleys comprises about 3 percent of the Study Area. The soils of this unit occur along Bush and Williams Draw and generally are classed as unsuitable as topsoiling material. These soils are more than 4 feet in thickness, are stratified and include loam, clay loam, and silty clay textures. The soils have appreciable amounts of sodium and because of the sodium and clay content, water movement through the soil mass is very restricted. Normally the water table is within 72 inches of the surface during some period of the year. Land use is primarily range, with a fair cover of salt and sodium tolerant grasses and shrubs.

Land Suitability

A detailed land suitability survey was made of the Study Area to characterize and evaluate the surface and underlying material, to a depth of 10 feet, in relation to its suitability as a source of planting media for resurfacing shaped spoils following surface mining. The survey provided data on the quality and quantity of surface material for revegetation and the ease of stripping and stockpiling. Basic data, such as present physical and chemical properties in the upper 10 feet of soil material, are also provided by the study.

Land classification specifications were developed specifically for this Study Area to establish ranges of land suitability as a source of planting media. Soil factors included in the specifications for quality consideration were: texture, salinity, sodicity, permeability, available water-holding capacity, and erosion hazard. Quantity considerations were primarily assessed by evaluating the depth and geographic extent of suitable material. Excessive slope and depth to bedrock outcrops were factors considered in relation to ease of stripping and stockpiling of material.

Four land suitability classes (1, 2, 3, and 6) were developed which closely correspond with the class numbers used in the Reclamation Land Classification System. Class 1 lands are the most desirable as a source of topsoil for surfacing shaped spoils. Class 2 lands have adequate resurfacing material, but may require special placement practices to meet such requirements. Class 3 lands are marginal in their suitability for reclaiming mined areas because of poorer quality soil material and/or lesser available quantities. Class 6 lands generally do not have adequate quantity or suitable quality material for topsoil use and should not be stripped and stockpiled. If class 6 lands are disturbed by surface mining, it will be necessary to borrow suitable material for revegetation to be successful.

Results of the land suitability survey show that approximately 87 percent of the Study Area has adequate material for postmining reclamation purposes. Approximately 67 percent of the Study Area is class 1. Class 2 and 3 land comprise about 10 percent each.

The remaining 13 percent of the Study Area was class 6. Lands in this class are unsuitable for use as a source of planting media. Deficiencies observed were fine textures, steep slopes, sodicity, and areas having insufficient quantities of strippable material.

Overburden Suitability

The land suitability survey classified lands for their suitability as a source of planting media taking into consideration many factors including soil depth up to at least 10 feet. A quality evaluation of the overburden suitability from a depth of 10 feet to bottom of coal seam was made, based on data derived from chemical and physical laboratory tests on core taken from six deep-hole borings drilled on the site. In the event adequate topsoil or suitable soils are unavailable, suitable overburden may be considered.

The suitability evaluations were rated on a broad scale as suitable, limited, or unsuitable. Applicable parts of the specifications used for the land suitability survey were used to provide criteria for the ratings. The suitable rating is equivalent to class 1 and the best of class 2. The limited rating is equivalent to the lower part of class 2 and class 3. The unsuitable rating is equivalent to class 6.

The quality evaluations, displayed in the main report, apply to the specific core site. Because of the limited number of holes drilled and the nature of the geologic material, the quantity and quality evaluations of the core overburden should not be projected between drill hole locations.

VEGETATION

Significant variations in species, proportion of species, and total annual production, due largely to the differences in soil, topography, and other environmental factors, causes vegetative dissimilarities within the plant community at the McCallum Study Area. Based on these factors, seven ecological subdivisions or range sites are found within the 2,960-acre area: mountain loam, dry mountain loam, drainage bottom, clay pan, valley bench, dry exposure, and salt flat.

The vegetation of the Study Area is mapped according to the various range sites.

Mountain Loam

This range site is the most productive site within the Study Area in terms of total annual vegetative production. The site is dominated by big sage brush, which accounts for 67 percent of the total air-dry weight composition and approximately 26 percent of the cover. Associated dominant understory vegetation includes some of the more moisture demanding grasses, such as Idaho fescue and mutton bluegrass, along with various wheatgrasses.

Mountain Loam - Treated

This site is fifth in terms of total annual production within the Study Area. The vegetative composition of this area is predominately grasses with more than 50 percent of the composition being Idaho fescue along with various wheatgrasses, muttongrass, and pine needlegrass, which account for 39 percent of the vegetative composition.

Dry Mountain Loam

This range site is fourth in terms of total annual vegetative production within the Study Area. The site is dominated by the shrub component. Big sagebrush and rabbitbrush contribute approximately 66 percent to the total annual production. Bluebunch wheatgrass, muttongrass, and Idaho fescue are the dominant grass components.

Dry Mountain Loam - Treated

This treated area is second in terms of total annual production within the Study Area. Muttongrass, various wheatgrasses, and Idaho fescue contribute 16.3 percent, 19.8 percent, and 6.3 percent, respectively, to this production. Pine needlegrass and junegrass also form a significant part of the understory. Big sagebrush and rabbitbrush contribute 19.9 percent and 27.4 percent, respectively, as oppposed to 55 percent and 10.8 percent in the untreated dry mountain loam area.

Dry Exposure

This site is eighth in total annual production within the area having a predominately grass and cushion-type forb plant community. The wheatgrasses dominate the grass production, while phlox, fringed sage, and loco are the major forb producing species. Low sage and low rabbitbrush comprise the shrub composition.

Salt Flats

This site is the lowest in terms of annual vegetation production within the Study Area. The site has a salt tolerant shrub-grassland plant community. Western wheatgrass and alkali sacaton are the dominant grass species totaling approximately 24 percent of the annual production, while phlox, stonecrop, and aster comprise the forb composition producing nearly 15 percent of the annual production. Sagebrush, winterfat, rabbitbrush, and greasewood comprise the majority of the shrub composition which totals approximatley 57 percent of the total annual production.

Valley Bench

This site is seventh in total annual production within the area and contains a grassland-sagebrush plant community. Bluebunch wheatgrass, muttongrass, and junegrass are the most frequently occurring grasses totaling approximately 51 percent of the total annual production. Big sagebrush and low rabbitbrush account for 27 percent of the production while fringed sage, phlox, and stonecrop make up the forb composition totaling approximately 16 percent of the total annual production.

Clay Pan

This site is sixth in total annual production within the area and supports a sparse, low appearing, shrub-dominated community. Alkali sagebrush is the dominant shrub species accounting for 63 percent of the total annual production. Low rabbitbrush is also quite prevalent. Pine needlegrass, Sandberg bluegrass, squirreltail, and various wheatgrasses are the principal grass species.

Drainage Bottom

This site is third in total annual production within the area. Runoff and a high water table provide the medium for a plant community domainted by sedge and rush Spp. These two comprise aproximately 64 percent of the total annual production. Wheatgrass Spp., tufted hair-grass, and Muhly Spp. are also important components of the annual grass production. Of the nine sites sampled, this area has the greatest diversity in terms of forb composition. Rocky Mountain iris, pussytoes Spp., and thistle Spp. are the principal producers.

HYDROLOGY

In order to determine the potential effects of surface mining on the environment of the McCallum area, it is necessary to understand its hydrology. Surface-water data have been obtained for the McCallum area since 1979, primarily in the Williams Draw basin. These data have provided a basic understanding of the runoff and water-quality characteristcs of the basin. Recent data observed for runoff and water-quality characteristics on Williams and Bush Draws were used to improve and verify the interpretations provided in the main report.

Ground-water data for the McCallum Study Area are practically nonexistent, therefore, the conclusions on that subject are tentative. Additional data are needed for a basic understanding of the ground-water hydrology.

Surface Water

The gently rolling topography of the McCallum Study Area is drained by two ephemeral streams, Williams Draw and Bush Draw, both of which are northeast-flowing tributaries of the Canadian River. The Canadian River, northeast of the McCallum Study Area and the only major perennial stream nearby, flows northwesterly out of the Medicine Bow Mountains and across the eastern portion of North Park, where it has developed a flood plain one-fourth to one-half mile wide.

Although no irrigation of hay meadows takes place in the McCallum Study Area, the use of water for livestock and wildlife watering is of some importance. Water for this use is provided by several stock ponds in the Bush and Williams Draw basins and a small, developed spring in the SW1/4 sec. 22.

Ground Water

Small to very small amounts of water may be found under favorable conditions in the Pierre Shale, Coalmont Formation, alluvium, and older terrace deposits in the McCallum Study Area. Although generally considered impervious in North Park, the Pierre Shale may yield small quantities of water from sandstones and siltstones in the Study Area. Ground water in the Pierre Shale is most likely to be found at shallow depths, because the water is transmitted primarily by fractures, which are wider and more numerous near the surface.

The only use of ground water in the area is to water stock. Ground water and streamflow furnish water to stock ponds in Williams Draw and Bush Draw during wet weather, but ground water is the only source of replenishment during dry periods. Seeps in the bottoms of these draws also form shallow pools that are a source of water for livestock and wildlife.

CONCLUSIONS AND RECOMMENDATIONS FOR RECLAMATION

Postmining Land Use Recommendations

The McCallum area, if mined, should be returned to its approximate original land form with quantities and quality of vegetation necessary to promote the three primary postmining land uses - livestock grazing, watershed cover protection, and wildlife habitat. In general, postmining reclamation should ensure the continued present primary resource at approximately the same base levels. Reclamation should also ensure the return of air and water quality to premining base levels.

Resource Relationships to Reclamation Practices

Planting Media

The soil quantity and quality evaluations of the McCallum Study Area indicate that a successful revegetation program is feasible when the topsoil or similar soils identified as suitable in the land suitability survey are used as a planting media. In the Study Area there are approximately 2,591 acres of class 1, 2, and 3 lands. These lands include 1,992 acres (class 1) having a minimum of 36 inches of highly suitable strippable material; 299 acres (class 2) having a minimum of 24 inches of usable strippable material; and 300 acres (class 3) having a minimum of 6 inches of usable strippable material. The land suitability survey should be intensified when accurately establishing cut stakes for topdressing material.

Sections 22, 27, and portions of 28 appear to have more than adequate highly suitable strippable material available for stockpile or for direct use from the mining area to other areas being rehabilitated in the McCallum Study Area. Sections 23 and 26 have adequate strippable material, however, the draws in these sections are comprised of saline and sodic soils, and these class 6 soils should not be used for topdressing but added to the spoil pile.

The fine textured subsoils, particulary clays, in the class 2 areas should be separated from the topsoil in the stripping operation. A double lift method of removing topdressing should be used where these subsoils are encountered to ensure proper placement practices.

Climate

Lack of precipitation during the growing season is the factor most limiting to revegetation efforts. The combination of extreme cold, high winds, very dry air, warm daytime temperatures, and lack of snow cover will cause winterkill for some young plants. Temporal distribution of the estimated 11 to 12 inches of precipitation that falls at the site will determine the success of plant species at progressive developmental stages.

Fall seeding (for spring germination) is preferred because it allows the new seedlings to take full advantage of spring precipitation for plant establishment. Available data indicate that the last week in October is generally the best time for seeding. This particular time avoids premature germination resulting from late warm periods and allows for seeding prior to major snowfalls. Seeding at this time promotes early spring germination and maximizes use of available moisture.

Treatments to increase optimum conditions for productive growth should inclde mulching, land surface shaping and/or contouring, enhancement of snow accumulation, and distribution by the use of snow fences or windbreaks. High wind conditions occur several times each winter. Snow fences can be used to protect ridges and lee slopes from wind erosion and desiccation. Also, increasing the surface roughness enchances snow accumulations, reduces wind erosion, and minimizes the winterkill problem.

Hydrology

The overall effect of mining on the hydrology of the area should be minimal, primarily because only small areas of the basins would be mined. The type of mining and reclamation practices used will be the major factors involved in maintaining the hydrologic balance of the area.

The loss of water in stock ponds and springs is a potential effect of mining due to the dewatering of aquifer systems. If this occurs, alternate sources of water for livestock and wildlife should be provided.

Mining should not cause significant increases in sediment concentrations and load if natural buffer zones are maintained between the disrupted areas and the stream channel. Proper design of any roads, stream crossings, and water-conveyance channels would also help keep sediment-discharge increases to a minimum. The loss of riparian vegetation in Williams or Bush Draws because of dewatering of alluvial aquifers could result in increased erosion; thus, increased sediment is possible in these streams.

Reclamation Procedures

The success of erosion control, establishment of vegetation, and results of postmined land reclamation can be enhanced with techniques of spoil shaping and recontouring. This phase of the reclamation effort must be addressed in the reclamation plan and would be completed prior to redistributing topsoil.

A moderate slope gradient (less than or equal to 10 percent) will reduce the erosion potential on reclaimed areas initially and in the long term by reducing the energy of surface-water runoff.

Contour terracing should be considered in the reclamation plan for the McCallum Study Area to further alleviate erosion and enhance the retention of water on the slope.

An alternate method of trapping moisture on south and west facing slopes would be to construct contour furrows. However, periodic maintenance is required to sustain the effectiveness of furrows. Contour furrows are not recommended as a substitute for terraces on north and east facing slopes, since furrows would fill and break, causing severe gullying as the snowmelt drains downslope.

Before topsoil is placed on the overburden, an undulating interface should be created between the two surfaces. A chisel plow or ripper can be used to breakup the overburden, alleviating compaction from grading operations and eliminating a potential barrier to water percolation and penetration of roots. In addition, an undulating interface between topsoil and overburden stabilizes topsoil redistributed on slopes, reducing the possibility of water piping or slippage of the topsoil. Ripping operations on overburden should occur along the contour of slopes.

Use of freshly stripped topsoil for redistribution on overburden is preferable. This procedure would eliminate stockpiling and maintain a viable population of micro-organisms in the seedbed.

Seedbed preparation begins prior to the redistribution of topsoil ensuring a rough interface between the overburden and topsoil. Preparation must include the proper techniques of applying the topsoil dressing. The objectives of revegetation are enhanced by utilizing the best plant growth medium. After topsoil is distributed, it will require some additional cultivating before a suitable seedbed is achieved. Nutrient deficiencies should be corrected, the compaction of topsoil alleviated, and applying a provision for temporary protection of the seedbed prior to establishment of the postmined land plant community. These concepts establish and protect the seedbed through the first growing season of the perennial plants and can be achieved with fertilization, chisel plowing, and/or disking and mulching.

A standing stubble mulch is recommended for the McCallum Study Area to reduce the influence of wind on evaporation and windblown snow.

Several plant communities exist within the McCallum Study Area due to different soil types, management techniques and microenvironments including aspect. Assumptions are made at the time of seeding that the topsoils after application will have different chemical and physical properties than existed prior to mining, and, different properties will be characteristic in the reapplied topsoil at different locations.

The microenvironments will change as a result of mining, except on the larger scale inferred by aspect. The aspect in the McCallum Study Area greatly determines the species composition of a particular plant community.

The southern aspects and ridge tops are warmer and have less soil moisture. Plant growth is initially accelerated in the spring. These characteristics of temperatures and moisture, compounded by the drying influence of the wind, especially on ridgetops, persist through the summer.

Therefore, the aspect, specifically north and south aspects and ridgetops, should be delineated by acreage in the reclamation plan. Different seed mixtures, especially adapted to each aspect, should then be used to avoid unnecessary competition by unadapted plant species initially. Establishment of a self-perpetuating, diverse, stable plant community could be accelerated by the selection of plant species for a given aspect. Snow fences should be used to protect ridges and slopes subject to wind erosion and desiccation.

A perennial plant community can be established after mining by drill seeding, broadcast seeding, transplanting containerized or bare root materials, and transplanting mature plants with a specially designed front-end loader bucket. The transplanting methods are not suited for reestablishing a large area, but are useful to accomplish desired goals on specially suited sites. Late fall is the appropriate time to seed and the preferred time to transplant. However, bare root and containerized materials may survive well if planted very early in the spring.

Drill seeding is preferred over broadcast seeding. The drill can place the seed at a desired depth, drop seed at a uniform rate into furrows and compact the soil around the seed to enhance germination. Broadcast seeding can be accomplished by many methods and would depend on the acreage treated as to which method was used. Regardless of the method used, the seed must be covered with soil. If shrubs fail to establish from seed, then containerized or bare root stocks could be used to introduce these species into the plant community. A tree spade or special front-end loader bucket can be used to transplant individual trees and shrubs or pads of soil containing native grasses, forbs, and shrubs, respectively.

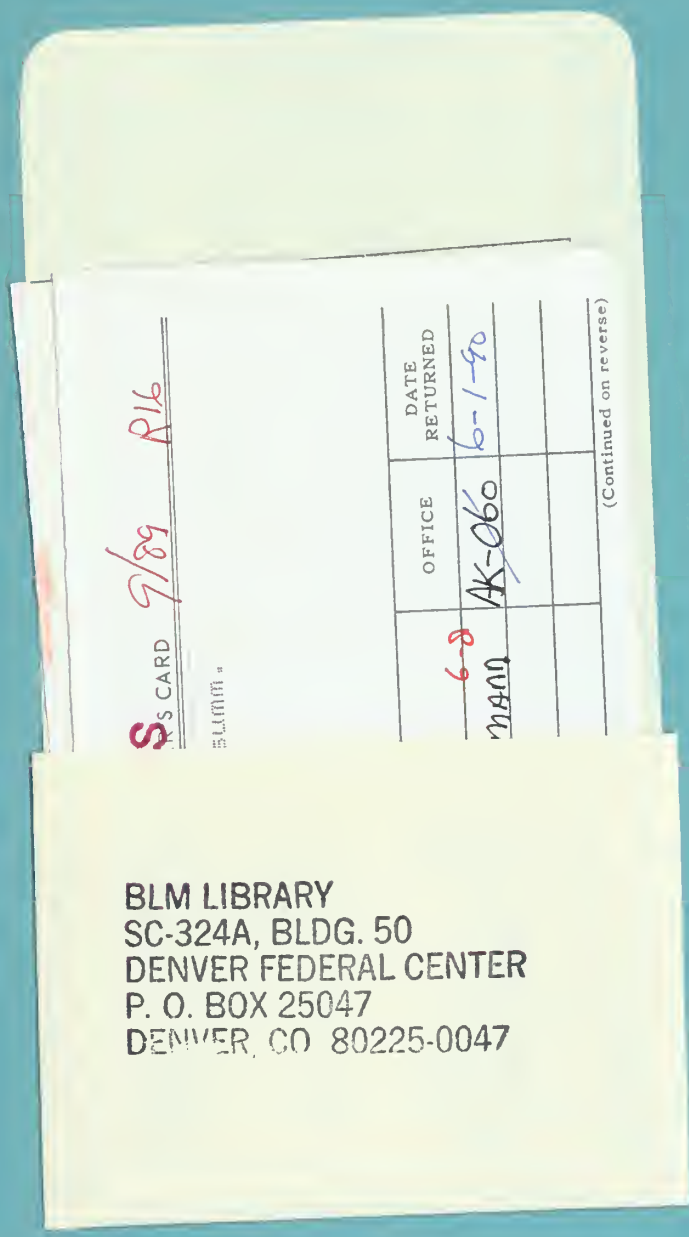
Material such as the fine textured subsoils found in the area should be mixed with gravel or coarse fragments (1- to 6-inch diameter) and placed in drainage channels to provide better growth medium, increase physical fertility, and act as anchor material. Maintenance of all terraces constructed should continue to ensure effectiveness and to repair damage by livestock, wildlife, and any subsidence that might occur.

Postmining Land Use Management

The reseeded area should be protected from grazing until vegetation is sufficiently developed and established to withstand grazing use without damaging the vegetation cover. Once established, a planned grazing system should be implemented.

A final reclamation plan for the area might require modification of the land form, such as terracing slopes which have been discussed, thus reducing its gradient. This practice, as well as other slope modification techniques, would be desirable practices in controlling sediment runoff, as well as providing the opportunity to create microhabitats, if necessary.

The recommended seed mixture should suffice for most habitat requirements; however, due to the harsh growing conditions prevalent at the site, it may be difficult to establish some of the woody stem species desirable for wildlife habitat. Special revegetation techniques, such as planting containerized seedlings, or use of the "sod bucket" may prove advantageous in obtaining successful reclamation in the area. Reclamation practices should strive to meet the wildlife habitat needs of the area.



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